A PLEA FOR THE METRIC SYSTEM IN MICROSCOPY.

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One of the most important questions, theoretical and practical combined, which is now fairly before the microscopical world and still in an unsettled state, is that of gaining definiteness and uniformity in *micrometry*. In this field emergencies have arisen during the past year which have compelled me to take considerable responsibility, as well as to perform a large amount of work, trusting that the generous approval of my colleagues would accept and ratify what seemed at the time, and what seems now, most consistent with the interests of science and the dignity of this body. It will be remembered that a year ago, just at the close of our Indianapolis meeting, resolutions were offered favoring the metric system for micrometry, and the one hundredth of a millimeter as the unit to be employed, inviting foreign co-operation, and accepting an offer of standard micrometers from Prof. William A. Rogers, of the Astronomical Observatory of Harvard University. None of these points, save the last, were new or unconsidered. They had been studied at leisure for years by many members who were present. The metric system had been adopted by all the world except Russia, England and the United States; and its universal adoption was, as a rule, earnestly desired and favored by the educated and scientific classes. It had been adopted, or recommended, after mature deliberation, by the National Academy of Sciences, the American Metrological Society, the American Association for the Advancement of Science, by the American Society of Civil Engineers, the United States Coast Survey, the United States Marine Hospital Service, the American Medical Association, the Congress of Ophthalmologists, and by the largest State and local Medical Societies and by leading Medical Schools and Journals, by numerous Boards of Education, College Faculties and local Scientific Societies, and by experts in various branches of science and art. On the other hand the resolutions contained some minor faults, mostly in matters of taste or tact, which could have been easily remedied by reference to a committee. But there was no time for reference or for adequate discussion, and rather than discourage their object by failure or postponement, they were adopted and referred to the local Societies for consideration. They were passed unanimously, at a small session, it is true, but by the same vote which established this society and authorized its meeting here to-day. As too often happens, their incidental faults attracted more attention than their really scientific object. The unit proposed was evidently too long for integers and too short for fractions, and unlikely to receive a single approval either at home or abroad; the proposal of international action, though its object was universally approved, was in a form not likely to accomplish that object; and the liberal offer of Prof. Rogers was wholly misunderstood and perverted, until it took the form of the preposterous statement that it was proposed to make Prof. Rogers' micrometers standard as distinguished from those of other (!) makers, not the least amusing of all the blunders and absurdities of this precious statement being that of bringing the association, in any manner, by trade rivalry or mercenary considerations in relation with the work of one of our most generous scientists who has freely shared with the public every result of his labors, while pursuing them at an extravagant cost, and without a thought of pecuniary return. It soon became evident that an organized treatment of the subject was required to secure a proper and unprejudiced discussion of the objects of the resolutions. Feeling much responsibility as the presiding officer of this Society, and of one of the oldest of the local Societies, but having no authority to appoint an evidently necessary committee that should represent not only this Society but also sections of the country not yet named upon our rolls, I brought the subject before our local Association, and we invited all the Societies that could be reached to join with us in the selection of a National Committee for the consideration of this subject. The response from the large and active Societies, and from distinguished individuals, was a cordial and almost unanimous approval. Many of the Societies nominated to the committee members distinguished as specialists in this branch of microscopy; both Societies and eminent scientists contributed valuable opinions upon all the points at issue; and a large committee was organized which will, at a proper time, tender a report of progress to this Society. And while speaking of this committee, I will take the liberty of saying that it would be a pleasure to me, and I doubt not to all of us on this side of the lakes, if our friends from Toronto or Montreal, or any other points in the Dominion which may be represented here, would nominate members, and thus make it an American instead of a national body. To prevent confusion or misapplication of the practical suggestions which follow, and which naturally belong to this time and place, it is necessary to anticipate the report of the committee so far as to say that it will recommend to this Society to rescind its approval of the one-hundredth of a millimeter as the unit of micrometry, and to so modify the forms of the other resolutions as to leave the important questions of accurate measurement and convenient and scientific nomenclature in a favorable form for the attainment of valuable results.

Whether this Society, as such, shall continue to be known as actively interested in this reform, it is for you to say; though I sincerely hope that the members will unanimously agree with me in judging that it ought to do all that its influence, without dictation, can do in this direction. But I for one do not deem the decisions of Societies or other corporate bodies decisive and final. I am not much elated by their approval, or discouraged by their opposition. I have an average amount of respect for the motives but not for the efficiency of legislation. In State, in Church, in Science, it is possible and easy to carry out laws about in proportion as they are unnecessary. People who do not need government are easily governed. Persons who appreciate authenticated micrometers will use them if they can, with or without the approval of societies; and those who do not desire them will be about as little controlled by official decisions. While the encouragement and support of Societies and officials are welcome and valuable as far as it extends, I have more faith in the power of individual influence, and to that I look for an example which is able to settle this question beyond appeal.

In our micrometry we have the anomaly of a system of work capable of a precision almost, if not quite, unknown elsewhere to human art, for what other wholly artificial procedure possesses a demonstrated limit of accuracy inside of the 1-300,000th of an inch, and yet, until now, we have made no reasonable effort to free ourselves from avoidable errors known to be many times larger than that amount. While coal at $4.00 a ton and muslin at six cents a yard are, or at least pretend to be, measured with apparatus that has been carefully verified by standards of known quality, we have been measuring spaces almost infinitessimally small by standards of only commercial quality and possessed of manifest and uncorrected errors. This fact is too suggestive of the days when micrometers consisted of grains of sand and clippings of wire; with the odds against us that we know how to do better. Arrange your microscope so that it will magnify 3,000 or 4,000 times, making the one-thousandth of an inch on the stage seem three or four inches long through the lenses, then arrange an ocular micrometer so that the magnified one-thousandth of an inch shall be covered by, for instance, one hundred divisions of the ocular scale, and finally ascertain exactly how many of the one-thousandths of an inch on that or any other plate will be similarly measured by precisely the same one hundred divisions above it. Judging from my experience and from that of others who have tried the experiment, you will probably find a perfectly measurable discrepancy between the different spaces of the same name; so that even your own measurements, with the same apparatus, will not be comparable with each other unless, as is often done, you select some one average space as a basis of comparison, and are careful to use only that. Now we are trying to ascertain which of these various spaces is the correct one; or if not one is right, then to obtain one that shall be; or if that can not be done, at least to determine a known error from which we can compute definite results. This is not a question of makers, or dealers, or trade interests in any form, but of unmixed and independent science. We are attempting to procure a standard because we need it, and we hope for the cordial assistance of microscopists of really

scientific spirit in the difficult work of attaining it, and in the almost equally important task of bringing it into general and respected use. I call this a standard for convenience, and not in a strict or ultimate sense. Strictly it is only an authenticated copy of a standard, or a portion of a standard, namely, of the world's standard meter or standard yard ; and hence, the importance, not fully shared by the original metre itself, of corresponding perfectly with its theoretical length.

The adoption of the metric system has a formal sound, and its difficulties have been, to say the least, well represented. But, to the extent of its use in micrometry, it really presents no difficulties and many advantages. The value of the millimeter and its decimals must be made familiar to the mind for other purposes, even for the understanding of exclusively English literature, and to use it for our measurements and statements will merely assist to keep it fresh in mind. The English system, or rather tradition, presents no pair of units so convenient for the microscopist as the millimeter for large objects and the 1-100oth millimeter for small ones. For the purposes of most people, for use in micrometry alone, it is sufficient to remember that the millimeter is about one twenty-fifth of an inch, and surely this is no great intellectual task. Nor would it waste a large portion of a lifetime to learn the whole series from the meter down, remembering that, in round numbers, the meter is a yard, with three or four inches to spare, the decimeter one-tenth of that 40 inches, or 4 inches, the centimeter one-hundredth of that 40 inches, or 4-10ths of an inch, and the millimeter one-thousandth of that 40 inches, or 4-100ths, or 1-25th of an inch. The real difficulty lies, I believe, not in memorizing the value of the few new units required, but in the awkward and useless habit of stopping to translate every item from the new unit to an old one. Any one can add a few new words to his vocabulary, a few new units to his tables, without harm. The telephone and the phonograph have brought no disaster along with their new double Greek names. An educated person can learn in an hour all the new terms, values and proportions of the whole metric system, with its interesting and suggestive relations ; and the time would be well spent though he never used the system again. But I know by experience that he can also use it again, easily. When you once learn by a little practice to think in the new units the same as in the old, the apprehended difficulties vanish unaccountably and can scarcely be brought to mind. If asked to estimate the width of this room in yards, only a child unfamiliar as yet with the practical use of measures would say to himself, "It seems to be about 90 feet, which would be 30 yards." You would rather look at the wall to see how many times longer than a yard it is. So if you will take a metric rule, learn well how the millimeter looks, and its dek, the centimeter, and learn to use it in measuring and estimating the size of suitable objects, such as insects or flowers, you will find it as easy to think in millimeters as in lines, inches, feet, or yards, to say nothing of the comfort of knowing that you are in no danger of being lost between several kinds of the same name.

Aside from the selfish though sufficient motive of our convenience, I hope we shall practically adopt the metric system, because we can thus contribute a trifle of influence toward its general introduction. It seems plain enough now that our country made a serious mistake in not adopting it at first ; and I am satisfied that it is still best for us to use it, notwithstanding the greatly increased difficulties in our way. It is not questioned that this is the best system ever tried or proposed, and the only one that can possibly come into general use ; it is not denied that it would simplify education, and substitute order and intelligible relations for the confusion of our present metrology ; it possesses as many points of convenient relationship to our old system as could reasonably be expected in any new one ; it is admitted to be excellently adapted to all scientific work ; it has been satisfactory to mechanics and manufacturers who have actually used it ; it has been gradually and completely introduced into large shops using costly tools and machinery, without serious expense, and to the satisfaction of the managers. Almost without exception its friends are those who have used it, and objections to it come from those who have not. You hear less of the evils it has caused than of those it would cause. Furthermore, it offers us a carefully elaborated scheme of international co-operation, which we have but to adopt in order to place ourselves in harmony with the rest ; the metric system is all international. It also unifies almost entirely the records made by persons adopting different units, since a statement of size will be practically the same to the eye and to the ear, and will require no formal mathematical reduction, whether in centimeters, millimeters, or in decimals of a millimeter. Fortunately we have all tried the experiment for ourselves, in one department, and know what some of the objections are worth. Our system of currency is precisely like the metric series of weights and measures ; and is marked essentially by the same evils and benefits. Who now believes that having adopted a currency incompatible with the English system has caused us a hundredth part of the trouble it has saved, notwithstanding that it lacked the advantage of putting us in harmony with the rest of the world ? Who now feels cut off from the past because of the change, or regrets the loss of the pounds and shillings so long as he has dollars enough and of the right kind (it is not easy to satisfy everybody about that) ? Who has found the poor oppressed and the laboring classes annoyed by the system we adopted ? Who has yet incurred a burdensome expense in hiring accountants skilled in a foreign and to us obsolete nomenclature to compute from the records of the past how many pounds, shillings and pence our grandmothers paid for their bonnets, or our grandfathers for their ships or their farms ? The truth is the new system is so much better for our present purposes that we are glad to use it as soon as we fairly know how ; and I believe that the same would be true of the whole metric system. We do not undervalue the records of the past, with their elaborate computations, and tables, and surveys ; but few of the people of to-day come in contact with these directly, and those few could afford the extra trouble for the sake of the far greater interests involved. It is not scholars to whom learning in an unfamiliar form is a terror ; they will spend lifetimes in working over such lore, merely for the pleasure of the work. And so much of it as is required for use in the daily life of the illiterate world is consistantly modified, and modernized, and adapted, by specialists of various kinds who inherit the progress of the past but adopt the fashions of the present.

To adapt a homely phrase which has remarkably vindicated itself, in another field in recent history, the proper way to introduce the metric system is to introduce it ; not to decide why others should use it, but to use it ourselves. Nor need we wait to be certain of the feasibility of securing its universal use. It may be profitably used in science though not accepted in trade. The chemists have adopted it fully and with satisfaction in their work, in their teachings and in their books ; the physicians are adopting it in different parts of the country, and the microscopists may well enjoy its facilities whether others do so or not.—(*Inaugural Address, Buffalo*, 1879.)

EXPERIENCE, says the *Electrician*, has shown that the life of a submarine telegraph cable is from ten to twelve years If a cable breaks in deep water after it is ten years of age it cannot be lifted for repairs, as it will break of its own weight ; and cable companies are compelled to put aside a large reserve fund in order that they may be prepared to replace their cables every ten years. The action of the sea-water eats the iron wire completely away, and it crumbles to dust, while the core of the cable may be perfect. The breakages of cables are very costly, and it is a very difficult matter to repair them, in comparison with a land line. A ship has to be chartered at an expense of $500 a day for two or three weeks in fixing the locality, and in avoiding rough weather, as cables can only be repaired in the calmest seasons. One break alone in the Direct Company's cable cost them £20,000 to repair, and the last chance left to the company was to make an agreement with the Anglo-American, so that they should be protected and have the use of that company's line when their own was stopped.